DOCUMENT RESUME

ED 479 429 IR 022 105

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TITLE	The Usability of the Virtual Hospital Round.
PUB DATE	2002-10-00
NOTE	8p.; In: E-Learn 2002 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education. Proceedings (7th, Montreal, Quebec, Canada, October 15-19, 2002); see IR 022 093.
AVAILABLE FROM	Association for the Advancement of Computing in Education (AACE), P.O. Box 3728, Norfolk, VA 23514. Tel: 757-623-7588; e-mail: info@aace.org; Web site: http://www.aace.org/DL/.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS	Computer Assisted Instruction; *Computer Simulation; Educational Technology; Higher Education; Instructional Effectiveness; *Instructional Material Evaluation; *Instructional Materials; *Medical Education; *Medical Students; Multimedia Materials

ABSTRACT

A usable instructional system is defined as a system that enables learners to accomplish learning goals or tasks in an effective and efficient way. This paper investigates the usability of the Virtual Hospital Round (VHR) prototype, and explores medical students' and professionals' attitudes toward the VHR system. Results of the evaluation of the prototype indicated that students and medical professionals liked and valued the program as a useful and enjoyable learning tool. The interface was mostly easy to use. The prototype stimulated learning and clinical reasoning. (Author)

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ED 479 429

The Usability of the Virtual Hospital Round

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Abstract: A usable instructional system is defined as a system that enables learners to accomplish learning goals or tasks in an effective and efficient way. This paper investigates the usability of Virtual Hospital Round (VHR) prototype, and explores medical students' and professionals' attitudes toward the VHR system. The evaluation of the prototype indicated that students and medical professionals liked and valued the program as a useful and enjoyable learning tool. The interface was mostly easy to use. The prototype stimulated learning and clinical reasoning.

Introduction

There are large number of methodologies exists for evaluating the usability and usefulness of information technology program. Oliver & Conole (1998) at the Open University developed a toolkit to help researchers in selecting an appropriate method for evaluating information technology program. The aim of this paper is to evaluate the VHR prototype. Thus, initially a brief overview of the prototype is provided. Then, the general usability method used to test the VHR is explained. Furthermore, the perceptions of medical professionals towards this type of learning environment and students' attitudes while working with the system are discussed.

Virtual Hospital Round

A Virtual Hospital Round (VHR) was developed for the domain of Cardiovascular diseases. The VHR prototype consists of an Interactive Hypermedia Library and a Cyber-Round. The Interactive Hypermedia Library enable students to explore a topic according to their learning style preferences. The Cyber-Round provides students with a simple simulated patient on which to practice clinical diagnostic reasoning abilities (AlRawahi, 1999). The design of VHR was influenced by Gardner theory of Multiple Intelligences (Gardner, 1983; 1993a; 1993b).

I. The Interactive Hypermedia Library

The adaptive Hypermedia Library contains study material (in several formats) about basic clinical science and the pathophysiology of diseases. As an implementation of Multiple Intelligences theory, the library web interface presents material in a set of different combinations of intelligences. The presented material can also be viewed according to traditional ways of teaching, or with multiple representations for comparison purposes. Figure I illustrate the VHR library interface.

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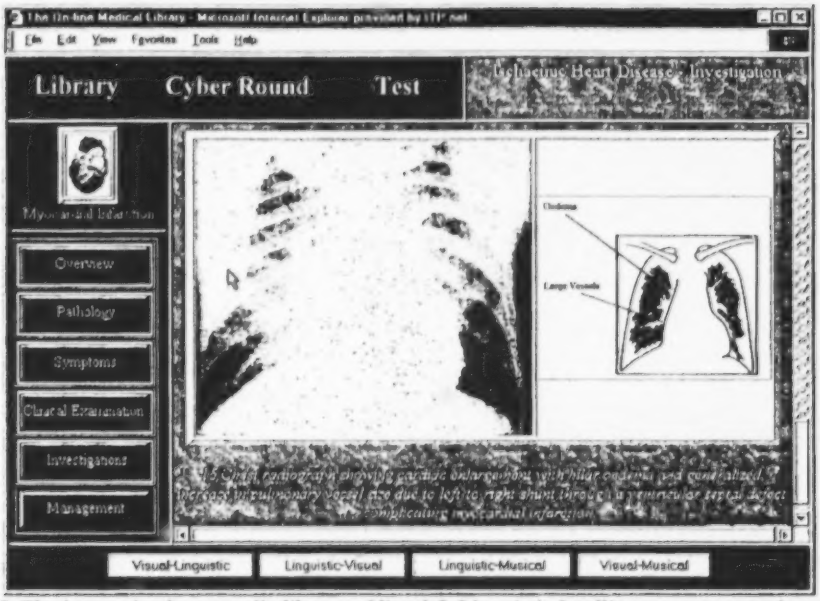

Figure I. The interactive hypermedia library – Visual & Linguistic Intelligence representation

II. The Cyber-Round

The interactive Cyber-Round section is a practice-based learning tool in cardiovascular diseases, where learners can explore one or more clinical cases. Students are provided with a rich virtual environment to practice medicine similar to the actual hospital round. They are given a simple, simulated patient with which to practice clinical skills. The system tracks students' progress while they work with the simulated patient. They can start by taking the patient's history, selecting from a menu. They then can choose to

- Perform a physical examination (using a mouse to click on an interactive patient image),
- Hypothesize a differential diagnosis,
- Request laboratory or radiological tests, and/or
- Diagnose the patient.

To resemble the hospital rounds and to give a sense of reality, students are given a reasonable amount of freedom to perform the task, according to their intuition, as they would in a real situation. Figure II illustrate the Cyer-Round interface.

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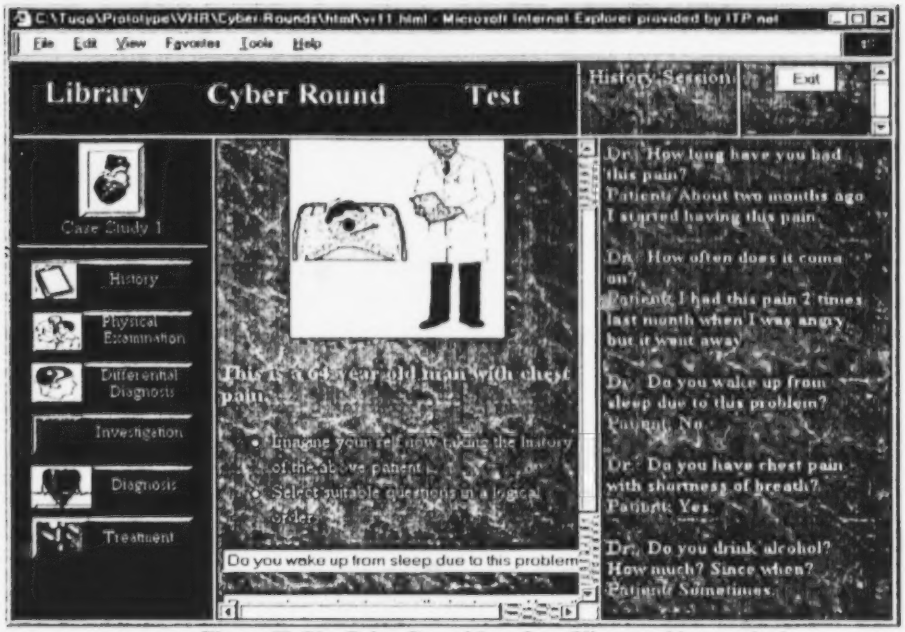
File Edit View Favorites Tools Help
Library
Cyber Round
Test
History Session
Exit
Case Study 1
History
Physical Examination
Differential Diagnosis
Investigation
Diagnosis
Treatment
Do you wake up from sleep due to this problem
Dr: How long have you had this pain?
Patient: About two months ago I started having this pain.
Dr: How often does it come on?
Patient: I had this pain 2 times last month when I was angry but it went away.
Dr: Do you wake up from sleep due to this problem?
Patient: No.
Dr: Do you have chest pain with shortness of breath?
Patient: Yes.
Dr: Do you drink alcohol? How much? Since when?
Patient: Sometimes.

Figure II. The Cyber-Round Interface (History taking session)

General system usability

Generally, researchers in the area of system usability define a number of usability criteria which must be met when designing a usable system. The PLUME (Browne & Simpson,1996) system encompasses most essential elements of testing an interactive learning environment, so it was used as a general evaluation method for the VHR prototype. The PLUME system emphasizes that a usable system must embrace the following characteristics: productivity, learn-ability, user satisfaction, memorability and a low error rate.

This section gives an overview of the definition of the different PLUME elements:

A. ***Productivity*** - a productive system is a system that enables learners to carry out the learning tasks quickly. This is important in clinical education, since medical students are busy and normally tend to discard most noncompulsory duties. Providing them with a productive system that helps them to process their learning more quickly is a necessity. Therefore, it is crucial to evaluate the productivity of the VHR.

B. ***Learnability*** - a learnable system is a system requiring little training. If systems are easy to learn and match the way the learner approaches a task, this will enhance learning.

C. ***User satisfaction*** - learner satisfaction motivates students to spend a longer time with the system, to learn and understand more.

D. ***Memorability*** - if system processes are memorable, learners will require less training and will be able to return to maximum levels of performance more quickly after absences.

E. ***Low Error Rate*** - a measure of the accuracy of the work carried out to complete tasks.

Method

11 fifth year medical students and 3 medical professionals with a minimum of three years experience as a general practitioner filled in a general usability questionnaire after they had worked with the VHR prorotype. This questionnire (see Appendix) was very short and simple and invited respondents to assess the system against the five PLUME criteria. It concentrated on the main system usability elements as discussed above. The users were given an explanation of each usability element and then they were asked to rank each element from 1 (least usable)-10 (most usable).

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Results

The average for each element was calculated by summing up students' responses to the usability questionnaire and dividing it by the number of subjects. Then the percentage score was calculated by dividing the average score by the maximum score (10). Table 1 presents the main findings from the usability study. As indicated in this table medical students seem to value the prototype more than medical professionals.

Medical professionals assigned 80% for the VHR's productivity. While, medical students assigned it 91%. Regarding prototype learnability, medical professionals gave it 78% while medical student gave it 83%. Moreover, the satisfaction of medical professionals was 83%, while the satisfaction of medical students was 95%. Medical professionals estimated the memorability of the VHR prototype as 80%, while medical students thought it was worth 85%. Finally, the estimate of low error rate when using the prototype were given by medical professionals and medical students as 75% and 80% repectively. The higher the percentage of the error rate indicate that students had less difficulties or frustration working with the protoype.

PLUME Metrics	Medical Professionals	Medical Students
Productivity	80%	91%
Learnability	78%	83%
User-satisfaction	83%	95%
Memorabilty	80%	85%
Error rates	75%	80%

Table 1. Findings for the general usability elements.

Medical professionals' perceptions of the VHR

This section reports on medical professional's attitudes towards the usefulness and effectiveness of VHR as an instructional system.

Method

Initially, three graduate medical professionals were given a brief summary about the main objectives of designing the VHR and this evaluation. Then they were shown how to work with different sections of the VHR prototype. After that they were asked to work with the prototype and to examine its contents and functionality. They were asked to comment about the following:

1. The level of the material presented in both the adaptive medical hyper-media library and in the CyberRound cases;
2. The accuracy of the material presented in both the adaptive medical hyper-media library and in the CyberRound cases;
3. The degree to which the program would motivate learner to learn more about the topic;
4. The degree to which the program would help students to practice clinical reasoning skills;
5. The implementation of the various teaching methodologies;
6. The comparison between the VHR and the OSCE study material;
7. The value of the program as an educational tool;
8. What they liked and disliked about the program;
9. Any suggested modifications or improvements.

Results

The results of their input on the level of cases and material embedded in the VHR prototype indicated that Dr. H and Dr. N thought the level of material would suit 5th year medical students, while Dr. T thought that it was most suitable for 4th year medical students. Regarding the accuracy of the materials Dr. N believed that 85% of the material were accurate, while Dr. H felt 82% was accurate, and finally Dr. T assigned 80% for information accuracy.

Would the program help students to practice clinical reasoning skills?

The three medical professionals believed that the program would help students to practice their clinical reasoning skill through their exposure to authentic cases in a simulated environment. They thought the main advantage of these simulated cases was that they would guide students to practice the whole clinical reasoning process. For example, students could follow through on a simulated patient, including ordering lab tests.

While, medical students think the program is helpful in a way that if a mistake was made it will not be on a real patient. Medical students thought this point might help them to feel calm when practicing, while normally students feel uncomfortable or frightened.

Implementation of teaching methodologies

The medical professionals were pleased to see different representations in the learning environment. They believed these representations were very useful for medical students. All of them liked the visual-linguistic representation most and they appreciated the other representations. Two of the medical professionals thought that allowing students to choose the representation they prefer from among the representations (multiple modality group) might confuse students and might cause loss of concentration.

Comparison between the VHR, the OSCE study material and real clinical teaching

The three medical professionals were asked to compare cases in the VHR with objective structured clinical examination (OSCE) cases. The cases in the VHR prototype were judged to be similar to the OSCE and case-based learning, but did not compare with actual physical examination training because of the need to palpate, and the need for percussion and auscultation. Furthermore, the three medical professionals believed that the cases in the VHR outperformed the OSCE and short cases in its method of history-taking and on the general management of a patient in terms of clinical reasoning for a given problem.

The value of the program as an educational tool

All three subjects believed in the value of the prototype as an effective educational tool for clinical practice. Furthermore, they highlighted that the main advantage of the simulated patients as always being available, unlike real patients. Moreover, they believed that computer based learning tool motivate students to review notes, books and discuss the case with a tutor or peer while solving the case. In their view, this is normally difficult when working with a real patient, as students in real practice need to think and act spontaneously.

Suggestions for modifications or improvements

The medical professionals suggested that immediate feedback on every step while solving the clinical case is needed, especially when users (medical students) act erroneously. Moreover, they wanted the patient management part to be implemented.

Discussion

This section summarizes results of the medical professionals' evaluations of the prototype. The results show that they believed that the VHR prototype would be an effective and efficient multimedia learning tool for fifth-year medical students. Moreover, they were satisfied with the content and functionality of the prototype. For instance, one subject liked the cases in Cyber-Round as case-based learning, and stated that the VHR might help medical students in their fifth year preparing for an M.D. examination. This is because medical students often waste time in hospitals finding cases to practice on before an examination. It was thought that the adaptive medical hypermedia library section would motivate students as they were getting information in different representations. The other two subjects thought that the cases in Cyber-Round would act as a useful tool for practicing history taking and clinical reasoning skills before going to the ward. Furthermore, they believed that the cases would be very helpful as preparation for clinical examination.

All three medical professional subjects liked the fact that the VHR prototype allows practice with all aspects of clinical reasoning activity, because in a clinical setting students rarely get to practice the whole process. Finally, the subjects hoped that the treatment and management portions of the prototype would be implemented.

Medical Students' Perceptions and Attitudes Toward the VHR

Medical students were observed using the prototype. Notes were made on students' attitudes towards the system while observing them carrying out general actions. Moreover, 12 students were interviewed and data gathered about their perception of the usability of the VHR prototype. Items discussed included perceptions of the importance of the program as a learning tool; perceptions of different tasks and their affect on problem solving; how the prototype compared to a real teaching round; and likes and dislikes regarding the system along with suggestions for modification.

Method

Students were asked to solve two clinical cases as they would normally do in actual clinical practice. In addition, while they were working with the prototype they were asked to think aloud and to verbalize what they were doing and why they were doing it. They were observed while they were working with the prototype and notes were taken on their general actions executed and on their impressions while working with different parts of the prototype. As the subjects were very busy and they were already spending a long time doing the experiment voluntarily, it was difficult to get many of them to fill out the usability questionnaire. Therefore, we carried out the usability evaluation as a conversation (informal discussion) after students had finished working with the prototype.

Results

- 92% felt the program was easy to navigate, while 8% felt the program was very easy to navigate.
- 80% felt the program did not require initial training, while 12% felt training might be helpful and 8% felt training was needed.
- 84% thought the program was interesting and forced them to think and to reflect on their knowledge.
- The only difficulty students faced was identifying the questions to ask in the history session and certain types of tests in the investigation session. The reason for this was that the pop-up menu was filled with a large number of items.
- Students believed that they learned from the program, and they felt the program was an effective educational tool.
- Students appreciated the opportunity to practice gathering information and working with a patient problem from beginning to end.
- Students reported that the prototype helped to test their existing knowledge, and to identify knowledge limitations.
- Students reported the VHR helped them practice reasoning throughout a patient case and helped to sharpen their thinking processes. The program 'forced' them to diagnose the simulated patient. The diagnosis process was less distressing than actual clinical practice.
- Students wished the system provided feedback on their actions.
- Students wished the management part of the system was implemented.

Synthesis

The study found that students liked and respected the program as a valuable learning instrument. Most students agree that the interface was easy to use. The VHR prototype motivated learning and fostered students' clinical reasoning skills. Students thought this type of practice gave them the chance to work through the case independently, without relying on a tutor who might be busy, and without relying on a real patient who might be unavailable, busy with other students, or in a state that students cannot use for practice.

The study found that medical professionals were satisfied with the value of the program as an educational tool. They thought that students could learn through practice and apply their knowledge by free inquiry with the simulated patient. Students could identify their own limitations in knowledge. This would motivate them to search for knowledge in the interactive hypermedia library of the system. Finally, computer patients are handy at any time and location, while real patients may not be.

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